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Rural and Urban Substance Use Differences: Effects of the Transition to College

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Abstract

Background: With approximately 20% of Americans residing in rural communities, substance use differences is an important topic for appropriate use of resources, policy decisions, and the development of prevention and intervention programs.

Objectives: The current study examined differences in alcohol, tobacco, and marijuana use among students from rural and urban backgrounds across the transition to college.

Methods: Participants were 431 (48% male) undergraduate students from a large, public southeastern university who provided yearly alcohol, tobacco, and marijuana use data during freshman, sophomore, and junior years.

Results: Prevalence of alcohol, tobacco and marijuana use were lower during early college years, and females were less likely to use tobacco and marijuana. Results indicated that rural individuals were less likely to use alcohol and marijuana than their urban counterparts as freshmen, but rose to meet the rates of urban students by junior year. In contrast, no rural/urban differences in tobacco were noted, although rural minorities were more likely to endorse tobacco use across all years. Finally, perceived peer use of each substance was a significant predictor of future use of that substance for all years.

Conclusion: This is the first study to explore rural/urban, gender, and racial differences in substance use across the college transition. Results suggest that there are subgroups of individuals at specific risk who may benefit not only from feedback regarding the influence of perceived peer use in college, but also from a deeper understanding of how cultural norms maintain their substance use behaviors over time.

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Keywords

Rural; urban; college; alcohol; marijuana; tobacco

With approximately 21% of Americans residing in rural communities,[1] substance use differences among those from rural and urban backgrounds is an important topic for policy decisions and the development of prevention and intervention programs. The purpose of the current study is to explore rural/urban differences across alcohol, tobacco, and marijuana use, and to examine whether potential differences remain throughout the first 3 years of college.

It is generally presumed that those from rural backgrounds engage in higher rates of substance use, an assumption likely driven by notable tobacco findings (i.e., early initiation and higher rates of use for rural individuals).[2,3] Aside from higher rates of tobacco use, studies have found that individuals from rural backgrounds engage in higher rates of methamphetamine use than those from urban areas.[4] However, other findings suggest that rural background may serve as a protective factor for other forms of substance use.[5,6] Data from the National Survey on Drug Use and Health (NSDUH) indicated that rural adults (over age 18) had *lower* rates of alcohol and marijuana use than their urban counterparts.[4] Similarly, in the Monitoring the Future Study, rural adults (age 19–32) had lower rates of alcohol and marijuana use than their urban peers.[7]

While national findings are important, considerable care needs to be taken regarding how rural/urban is defined and specific differences across the rural region(s) studied. As noted by Gfroerer and colleagues,[4] national studies such as the NSUDH are not designed to conduct rural/urban analyses, as rural participants are few in number and highly clustered. In addition, “rural” is not a homogenous designation that should be used at the national level; rural regions across the United States vary widely with regard to characteristics likely to impact substance use.[6,8] These regional differences can include cultural acceptance of substance use, religious values, and even availability of substances (e.g., “dry” counties common in the southern U.S.), all factors that may directly affect rates. As an example, rural regions in the southern U.S. show the highest alcohol abstinence rates of all rural regions.[8] Thus, when explored at the national level, rural/urban comparisons may be inaccurate due to regional divergence, and may therefore tell us little about specific risks.

Interactions with Gender and Race

Other demographic factors are likely to interact with rural/urban origin to affect substance use estimates. National substance use studies indicate that women use substances at lower rates than men.[9] It is possible that gender interacts with rural/urban background to differentially predict risk, as cultural acceptance of substance use by different genders can be quite different across regions.[10] Similarly, race is a known correlate of substance use, with whites typically demonstrating higher prevalence of alcohol and tobacco use than minority individuals,[9] and black individuals demonstrating a later age of onset for alcohol use.[11] Booth and Curran[12] examined alcohol use in black and white participants in six southern states and found that although urban black individuals reported higher abstinence than urban

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white individuals, racial differences were not found in rural areas. In fact, rural residence was found to be a protective factor for both groups.[12] Taken together, these factors may prove an important step in understanding use trends across rural and urban backgrounds.

Substance Use and the Transition to College

While there is an emerging research base documenting potential rural/urban differences in substance use, surprisingly little work examines changes in these groups over time. This is no small oversight; while rural background may appear a "protective" factor for alcohol use,[13] these static findings regarding prevalence may not remain after major life events. One of the major transitions for many individuals in young adulthood is college entry. Close to 40% of those age 18–24 will attend college in the U.S. In 2015, this number reached 20.2 million.[14] While fewer rural individuals enroll in college (31% vs. 46% from urban areas),[15] there are sufficient numbers of individuals to examine group differences.

College matriculation represents a time when multiple substance use risk factors converge.[16,17] The period of "emerging adulthood" is a time of notable transitions, including aging into legal adulthood, changes in residence, reduced supervision, changes in peer groups, and growing independence of decision-making, making this a critical period for in substance use risk.[18] In addition, college environments tend to normalize substance use, and provide increased access to alcohol and other drugs, thereby allowing considerable opportunity for substance use.[17] In fact, research suggests that heavy drinking is more likely among college students than their non-college attending counterparts,[19] and the initiation and use of marijuana and other drugs is more likely during this transition.[16]

Most certainly, some of the variance in substance use during college can be attributed to peer use.[20] Although the exact mechanism of this factor is still open to debate,[21,22] it is likely that peer modeling plays some role in substance use initiation.[23,24] Associations with substance using peers increases drug availability and normalization, which can be followed by selection of similarly-behaving peers, creating a reciprocally reinforcing trajectory.[25,26] Interestingly, emerging work suggests that the perception of peers' use, not actual use, is what guides subsequent substance use behavior,[27] indicating that perceptions of peer substance use may be a factor that works in conjunction with college transition.

The Current Study

While rural/urban and other demographic factors likely influence use prior to college matriculation, little is known about the degree to which exposure to the college environment affects initial differences. At this point, no work has examined the importance of rural or urban upbringing and substance use prospectively, across the college experience. Further, relatively few studies have examined the etiology of substance use among minority youth,[11] and we are not aware of any studies that have explored rural/urban, gender, and race differences in substance use over time. Finally, perceptions of peer use are a likely contributor to prevalence rates during a time when exposure to new friend groups is common and new relationships are formed. This study examined changes in substance use over time among undergraduate students from varied backgrounds. We examined prevalence of

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alcohol, tobacco, and marijuana use across a three-year period, thereby providing real-time data on how the college experience influences potential pre-existing group differences.

We hypothesized that there would be rural/urban differences in freshman year of college (rural individuals with higher tobacco prevalence, and urban individuals with higher alcohol and marijuana prevalence), but that time in college would reduce these differences to non-significance during sophomore and junior years. We also predicted that gender would interact with rural/urban background to differentially predict use, with rural women demonstrating significantly lower rates of alcohol and marijuana than all other groups, particularly for freshman year, and rural men demonstrating higher levels of tobacco use. We also hypothesized both whites and non-whites from rural backgrounds would demonstrate lower prevalence of alcohol and marijuana use during freshman year but this protective influence would be reduced throughout sophomore and junior years. Finally, we hypothesized that perceptions of peer use would remain significant predictors of substance use across all years.

Methods

Participants

Participants (N = 431) were from a large, public university in the southeastern U.S. who were assessed yearly for three years starting in the first year of college. Assessments were conducted throughout the fall and spring semesters to accommodate in-person, individual assessment of large cohorts of students. Participants were recruited from introductory psychology courses and received course credit and monetary incentives for participation.

Participants were pre-screened to bolster the volunteer sample through the identification of participants at risk for substance use in order to have sufficient variability to address the questions of interest. The screening measure assessed conduct problem behaviors that occurred prior to age 18, such as stealing, lying, and fighting (12 items, α = .75). A composite score determined the distribution of scores for predicted substance use risk (calculated separately by gender). Those whose scores fell within the top 25% for their gender were specifically invited to participate through email. Prescreened participants with early conduct problems made up 23.1% of the final sample.

Measures

Demographics.—Self-reported gender and race were collected during the first year of the study. Race percentages for non-white categories included black (12.4%), Latino/a (1.5%), Asian (2.5%), and other (2.5%). For the purposes of this study, all non-white categories (any named race that was not explicitly stated as “white” or “Caucasian”) were collapsed into the same “non-white” category.

Substance use.—The Life History Calendar (LHC) is a retrospective interview method for collecting data on life events and behaviors.[28] Information was obtained regarding tobacco, alcohol, and marijuana use. The reliability of the LHC as a retrospective measure of substance use has been documented previously.[29] At each assessment, participants reported

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on their substance use from the past year. Substance use for each year was scored as “use” or “non-use.”

Rural/Urban Codes.—Rural/Urban coding was determined using participants’ residence of origin and matching these addresses to the United States Department of Agriculture’s Economic Research Service[1] Rural-Urban Continuum codes (RUCCs). The 2013 RUCCs are a classification that distinguishes among metropolitan counties by population size, and among nonmetropolitan counties by adjacency to a metro area and degree or urbanization. The categories have been subdivided into 3 “urban” and 6 “rural” categories. Percentages of participants in each category is as follows: 1 (Metro - Counties in metro areas of 1 million population or more) = 39.5%, 2 (Metro - Counties in metro areas of 250,000 to 1 million population) = 18.6%, 3 Metro - Counties in metro areas of fewer than 250,000 population) = 5.9%, 4 (Nonmetro - Urban population of 20,000 or more, adjacent to a metro area) = 3.0%, 5 (Nonmetro - Urban population of 20,000 or more, not adjacent to a metro area) = 1.9%, 6 (Nonmetro - Urban population of 2,500 to 19,999, adjacent to a metro area) = 5.7%, 7 (Nonmetro - Urban population of 2,500 to 19,999, not adjacent to a metro area) = 4.6%, 8 (Nonmetro - Completely rural or less than 2,500 urban population, adjacent to a metro area) = 1.0%, and 9 (Nonmetro - Completely rural or less than 2,500 urban population, not adjacent to a metro area) = 1.7. For the purposes of this study, we utilized only 2 categories: Urban (coded values 1–3) or Rural (coded values 4–9).

Perceived Peer Use.—Perceived peer use was assessed yearly using a question that asked participants whether closest friend during the past year had used alcohol, tobacco, or marijuana (yes/no).

Procedures

The study was reviewed and approved by the university’s IRB, and a federal Certificate of Confidentiality was acquired from the National Institute on Drug Abuse. Informed consent was obtained from participants at each assessment.

Attrition

Data were collected for all 526 participants at Year 1. At Year 2, data were collected from 386 participants from the original sample, and at Year 3, data were collected from 332 participants from the original sample. Data from all three years were collected for 300 participants. Chi square and independent samples *t*-tests were completed to test whether there were significant differences on any study variables at time 1 (gender, race, tobacco use, alcohol use, marijuana use, rural/urban designation, perceived peer use, or conduct problems) between study completers vs. non-completers. Completion of data collection was not significantly associated with any of the study variables (all p’s>.05). Only 11 students out of the initial 526 discontinued their college education. We were unable to contact any of these individuals at time 3.

Statistical Analysis

All of the analyses were performed with SAS 9.4 (SAS Institute Inc., Cary, NC). Descriptive statistics were generated for the outcome variables and demographic characteristics by rural/

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urban status for each of the three data collection time points. Comparisons between rural/urban groups for the substance use proportions, demographics, and peer-use at each time point were performed with a chi-square test and Fishers exact test in those cases where chi-square assumptions were not met. Means were compared using a two-sample t-test.

These analyses were extended into Cochran-Mantel-Haenszel (CMH) models (two independent variables at a time; main independent variable was rural/urban group) that included gender and/or race stratifying variables. CMH modeling was applied as an intermediate step between simple rural/urban comparisons and multivariate analyses in order to test the potential interactions with gender and/or race via Breslow-Day (BD) test and assess potential confounding in instances where BD test is non-significant, ultimately providing better understanding of the outcome variables patterns for the covariates of interest. CMH models were applied for each college year separately.

Finally, we applied a generalized estimating equations (GEE) marginal model (with exchangeable covariance structure) for repeated measures in SAS PROC GLIMMIX, to estimate rural/urban status, time and their interaction effects, while adjusting for demographics. This approach allowed us to make use of all available observations over time. We also assessed the influence of peer use for each time point and substance with a similar GEE model as above, by adding it to the described model. While all other associations were considered significant at the alpha level of 0.05, instances of multiple testing (one for each college year) within simple comparisons and CMH analysis was considered significant at the alpha level of 0.017.

Results

Descriptive Statistics and Rural/Urban Comparisons

Table 1 presents overall characteristics of the sample, prevalence of substance use, and comparison between rural and urban students. Participants had an average age of 19 (SD=0.8), were 52% female, and 81% white. The majority (78%) were from an urban area. Based upon chi-square and Fisher's exact tests, no significant rural/urban differences were observed in demographic characteristics.

Overall rates of alcohol use approached 90% for each year. Alcohol consumption was initially significantly higher among urban students (p=0.0104), but in sophomore and junior years, rates increased for rural participants and groups were no longer significantly different. Tobacco rates were in the low to mid 20% range. Tobacco rates were not significantly different over time for either group, though in junior year there was a slight increasing trend among rural students and a decreasing trend among urban students (p=0.0707). Almost 50% of students reported marijuana use. Though not statistically significant, marijuana use was 11% higher among urban students during freshman year (p=0.0912), but by junior year, no such trend remained.

Perceived Peer Use

Rural/urban differences in perceived peer use are presented in Table 2. Chi-square test results indicated that more urban students reported that their closest friends used alcohol and

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marijuana than rural students across freshman and sophomore years, and fewer urban students reported that their closest friends used tobacco across all years. Perceived peer use was similar across rural and urban groups during junior year only, where the average rate of perceived peer use was 89% (urban) vs. 84% (rural) for alcohol, and 46% (both groups) for marijuana.

Cochran-Mantel-Haenszel models

Figures 1–9 present outcome trajectories over time for rural and urban groups, with additional subgroupings by gender and race. These are accompanied in the text with stratified Cochran-Mantel-Haenszel tests of the association between binary predictors and binary outcomes at each time point. Given no significant interaction were found, presented p-values conservatively correspond to the adjusted main effects.

Alcohol.—Figure 1 presents alcohol use trajectories for urban and rural groups for each study year. There were no significant alcohol use differences between rural and urban males during any study year. Figure 2 presents subgroupings for gender. Urban females reported significantly higher rates of alcohol use compared to rural females in each study year (all ps<0.05). Figure 3 presents subgroupings for race. Although urban white students reported significantly higher alcohol use rates than rural white students in freshman year (p=0.001), these differences were not observed in subsequent years. During freshman year, rural and urban minorities reported essentially the same rate (80%). However, by junior year, urban minority students' prevalence rose to over 90% while rural minorities remained at 80%.

Tobacco.—Figures 4–6 present tobacco use trajectories for rural and urban groups, subgroupings for gender, and subgroupings for race, respectively. There was little gender variability in rates over time, but in junior year, urban females reported significantly lower (p<0.05) tobacco consumption (12%) than all other subgroups. Across all three assessment points rural minorities reported significantly higher (all ps<0.05) tobacco use (~50%), compared to other subgroups whose use rate was in mid-20% range.

Marijuana.—Figures 7–9 present marijuana use trajectories for rural and urban groups, subgroupings for gender, and subgroupings for race, respectively. No significant differences were detected between rural/urban-gender subgroups. Females showed a trend for lower prevalence, with rural females being the lowest use group over the study period. Regarding race, significant differences were observed for both whites and minorities between rural and urban groups (p<0.05), but over time, rates between the four subgroups converged.

Generalized Estimating Equation (GEE) Marginal Models

A generalized estimating equation (GEE) marginal model (with exchangeable covariance structure) was applied for each *repeated* binary substance use measure in SAS PROC GLIMMIX to estimate rural/urban status, time, and their interaction effects while adjusting for demographics. Results for each substance (alcohol, tobacco, and marijuana) are presented in Table 3.

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Interactions—There were no significant interactions between rural/urban status and year of assessment for any of the substance use measures after the adjustment for demographic covariates. Perceived peer use did not confound urban effects for alcohol use, however it did at least partially explain early rural/urban differences for marijuana use as it changed the parameter estimate by approximately 20% when added to the model.

Main effects over time—Odds of alcohol consumption were 30–40% lower during freshman year relative to junior year (p=0.0031). Both urban status and white race were significantly associated with higher odds of alcohol consumption, compared to their respective counterparts.

While the odds of tobacco use were 23% higher during freshman year compared to junior year, this did not reach significance (p=0.0881). In addition, females were more than 30% less likely to report tobacco use than males (p=0.0466).

Odds of marijuana use were more than 20% lower during freshmen year relative to junior year (p=0.0457), and similar to tobacco use, females were more than 30% less likely to report marijuana use. Rural/urban status increased the odds of marijuana use by 43% but this did not reach traditional significance (p=0.0964).

Perceived peer use was a significant factor in predicting use of all three substances across all three time points (all p<0.0001).

Discussion

This study examined the prevalence of alcohol, tobacco, and marijuana, among rural and urban students across the transition to college. For alcohol, chi square comparisons indicated that alcohol consumption was higher among urban students during freshman year only. In subsequent models that included gender and race, results indicated that those from urban backgrounds, particularly white individuals, were more likely to report alcohol use. These findings are consistent with hypotheses, and are similar to other work indicating that white individuals, and those from urban backgrounds, have a higher prevalence of alcohol use.[4,7,9,12]

For marijuana, chi square comparisons indicated that no rural/urban differences were found during any study year. However, Generalized Estimating Equation (GEE) models indicated that during freshman year, those from urban backgrounds and males showed higher rates of use, although these differences were not significant. These findings are also in line with previous work.[4,7,9] For both alcohol and marijuana, freshman year rural and urban differences faded over the course of college, eventually resulting in no significant rural vs. urban group differences by junior year. These trends suggest that exposure to the college environment attenuates previous divergence.

Hypotheses were not supported for tobacco use. This is in contrast to previous work in this area.[2–4] However, subsequent analyses provided some clarity regarding this finding. When considering race in analyses, tobacco use was higher for rural minorities across all years of the study. The current findings indicate that rural minorities are at particular risk for chronic,

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unremitting use of tobacco. Importantly, after adjusting for covariates, rural/urban x time interaction effects were not significant.

This study also examined whether perceived peer use of these substances could account for the changing trajectories of use over time. Results indicated that perceived peer use significantly predicted use of all three substances for all three time points. This suggests that perceived peer use may contribute to these changes in use upon college matriculation. Specifically, upon entering college, young adults' perceptions of what their friends are doing is an important influence on their behavior.

Implications

The examination of gender and race interactions with rural/urban background provides a significant advancement of the literature given the dearth of studies in this area. Specifically, generalized rural and urban differences are quite different when subgroups are taken into account. As an example, rural female alcohol use prevalence remained low across all years, whereas prevalence of use rose for rural males. While the reasons for these subgroup differences cannot be explored in this work, results suggest that broad generalizations about rural/urban groups and substance use are inadequate to describe these populations.

These results also suggest that changes in use are not simply a matter of access. It appears that specific factors of protection are closely tied to the values these young adults learned, and these values' impact on substance use did not decrease in the face of environmental influences. Capturing the nature of these values, be they religion, gender roles, or culture, will likely lead to the use of these systems as anchor topics in effective prevention and intervention strategies.

The current results also suggest that specific subgroups are at risk for protracted use despite environmental influences to the contrary. For instance, tobacco use was consistently prevalent (~50% of the population) among rural minorities, despite declining rates among urban minority and urban white peers. This speaks to the need for availability of prevention and early intervention for tobacco use in rural communities prior to the onset of tobacco dependence.

Limitations and Future Directions

Although the current work addressed many potential background factors that affect substance use in college, due to lower rates of rural populations the size of these subgroups was limited. It is possible that failure to find significant differences for some substances by rural/urban categories is due to the low power to find effects, or that reported relations are less reliable (e.g., reproducible) given the small subgroup sizes. Future work examining use in populations selected for these characteristics may identify different relations. As an example, our sample rather low percentages of participants from each of the RUCC rural categories (e.g., with a range of 5.7% and 1.0% for categories 4–9), necessitated our use of a broad distinction or rural vs. urban only to ensure these categories were well-represented. It may be that substance use differences are related to the degree of rurality assessed on a continuum, but differences between the more specific categories can only be examined in a sample diverse enough to have adequate representations of these groups.

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In addition, the small minority subgroup did not allow for examination of specific minority groups, though most in this group self-identified as black. It is likely that different minority groups have differing attitudes toward substance use that could be further explored with targeted sampling of this important characteristic. The interaction between minority status and rural/urban background could also be more thoroughly explored with detailed assessment of other factors likely to covary with either or both of these designations, including socioeconomic status, parental education, or religiosity.

While the current study extends previous work by examining rural/urban trends in substance use through the transition into college, this prospective assessment ended upon junior year. Future work could explore use after college to provide information about how use changes for these students during senior year and beyond. Further, the large population sampled and individual testing sessions of the current study necessitated a lengthy assessment period, with students assessed throughout both the fall and spring semesters. While those assessed later in the semester may have had more exposure to substances (e.g., alcohol availability at college), this was a necessary aspect of this study design. Future work may specifically examine peer use and substance use rates among rural individuals entering college (during the fall semester only) to examine this transition more specifically.

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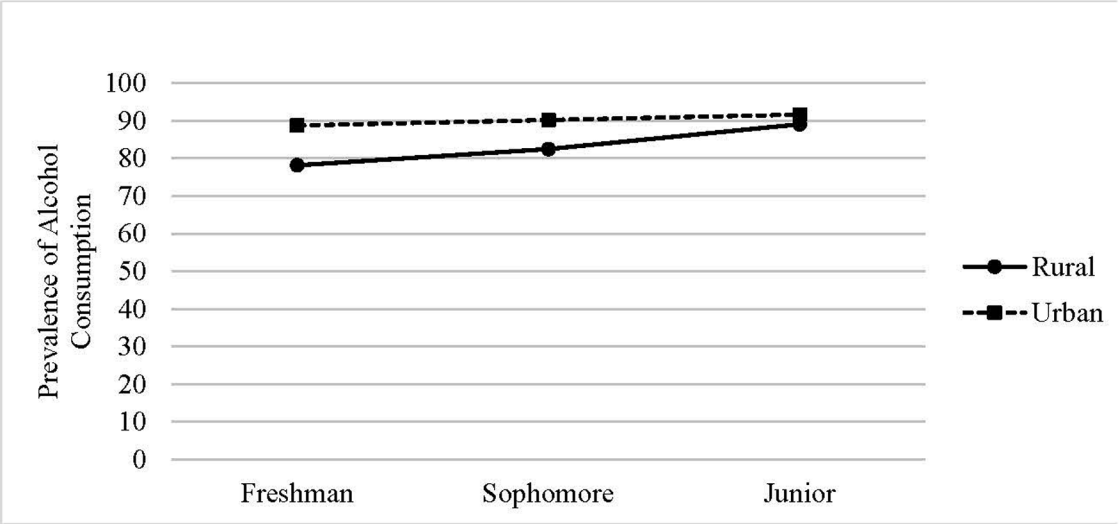

Figure 1. Prevalence of Alcohol Use among Rural and Urban Students.

Y-axis represents percent of group endorsing any use. X-axis represents year in college. Individual lines represent rural or urban student groups.

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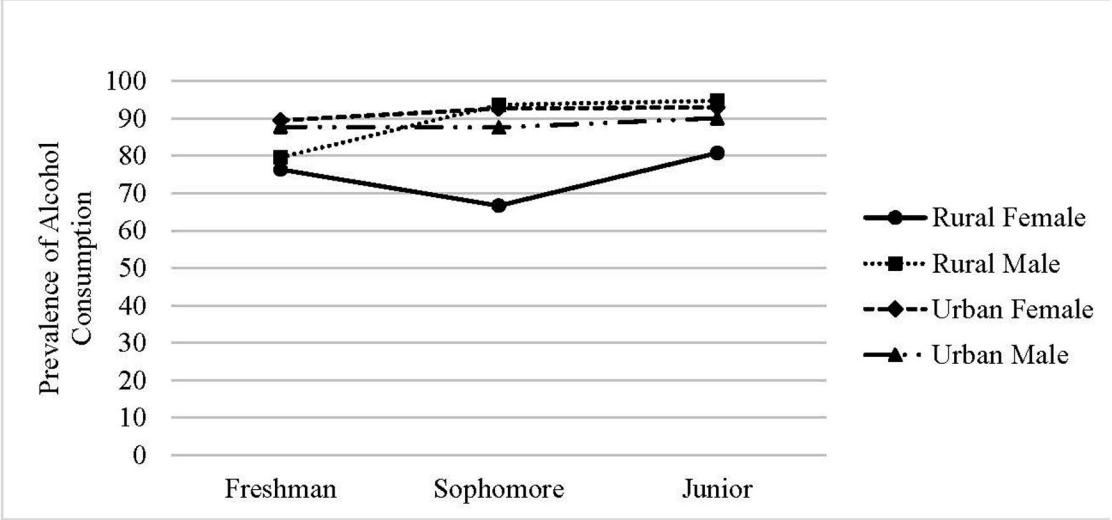

Figure 2. Prevalence of Alcohol Use among Male and Female Rural and Urban Students.
Y-axis represents percent of group endorsing any use. X-axis represents year in college. Individual lines represent rural female, rural male, urban female, or urban male student groups.

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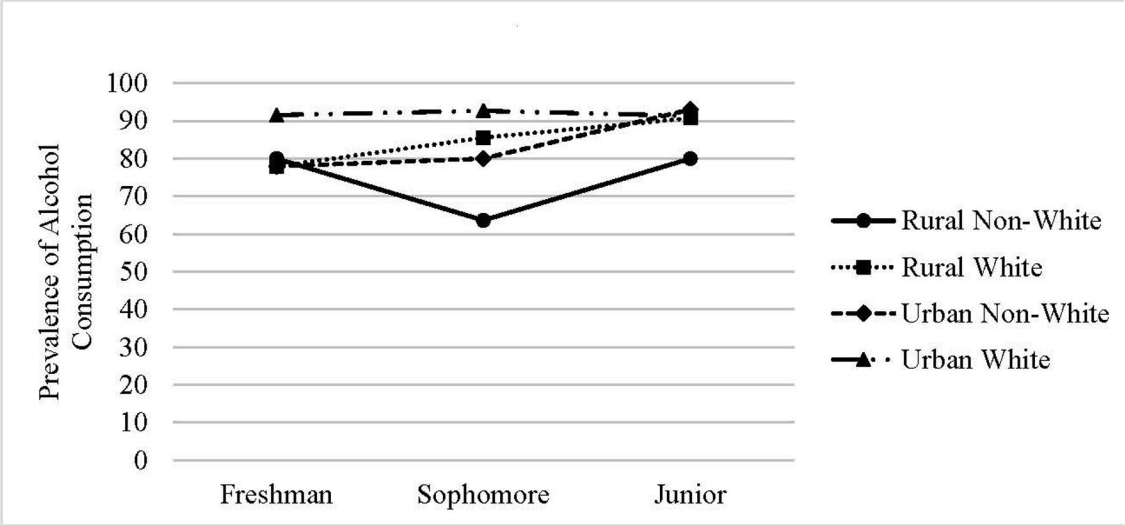

Figure 3. Prevalence of Alcohol Use among White and Non-White Rural and Urban Students.
Y-axis represents percent of group endorsing any use. X-axis represents year in college. Individual lines represent rural non-white, rural white, urban non-white, or urban white student groups.

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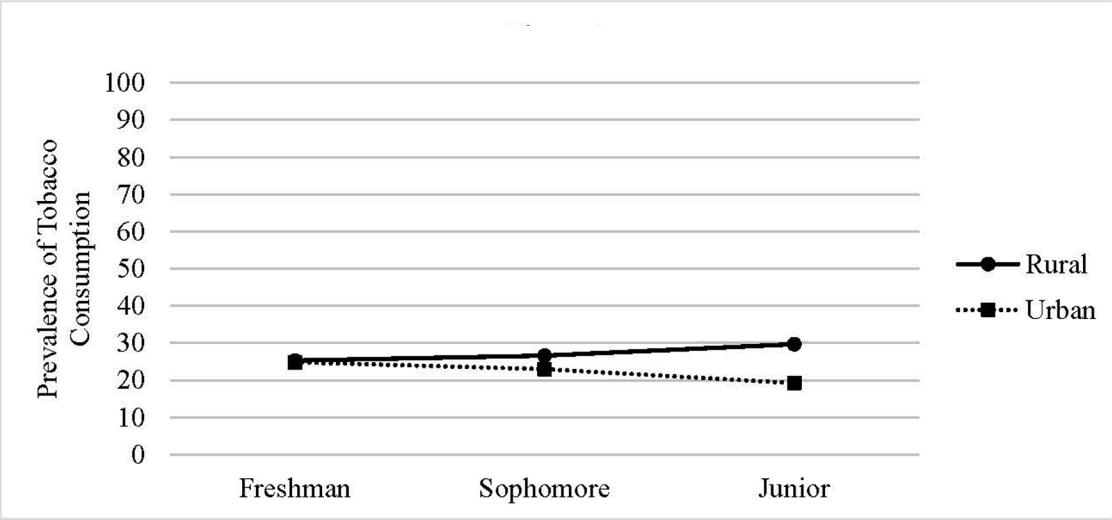

Figure 4. Prevalence of Tobacco Use among Rural and Urban Students.

Y-axis represents percent of group endorsing any use. X-axis represents year in college. Individual lines represent rural or urban student groups.

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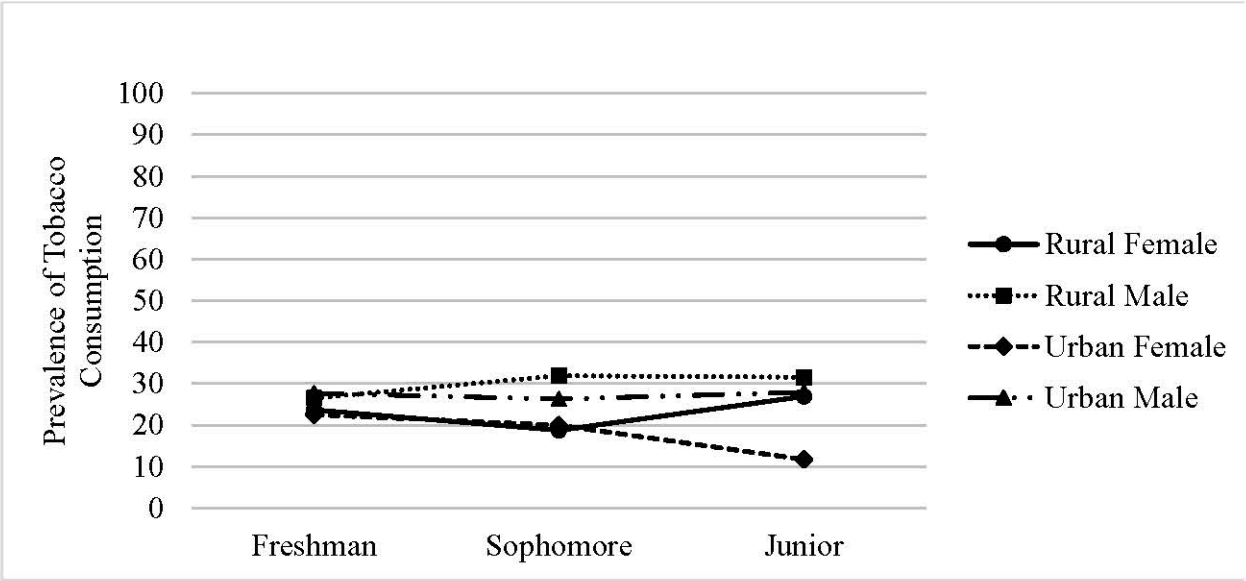

Figure 5. Prevalence of Tobacco Use among Male and Female Rural and Urban Students.
Y-axis represents percent of group endorsing any use. X-axis represents year in college. Individual lines represent rural female, rural male, urban female, or urban male student groups.

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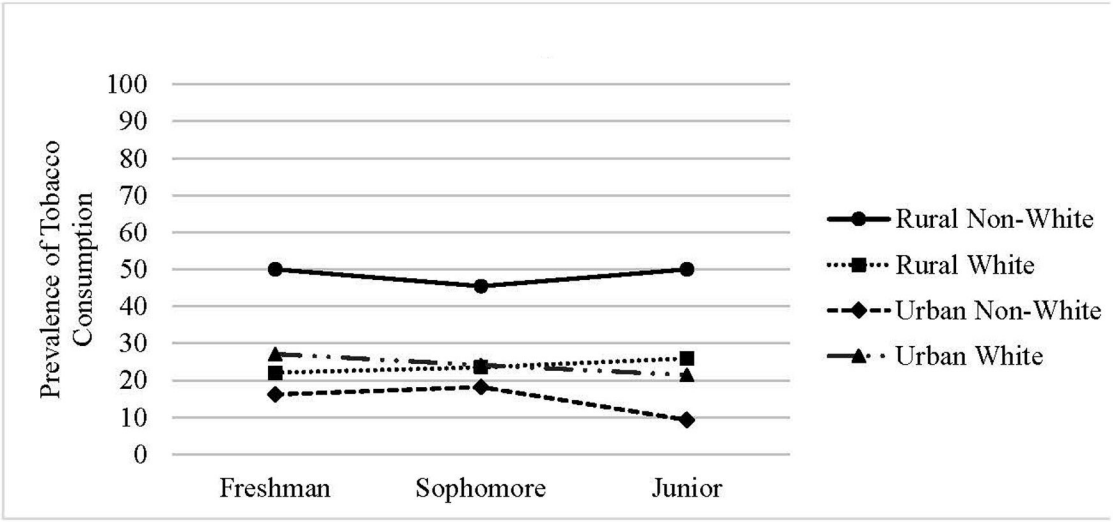

Figure 6. Prevalence of Tobacco Use among White and Non-White Rural and Urban Students.
Y-axis represents percent of group endorsing any use. X-axis represents year in college. Individual lines represent rural non-white, rural white, urban non-white, or urban white student groups.

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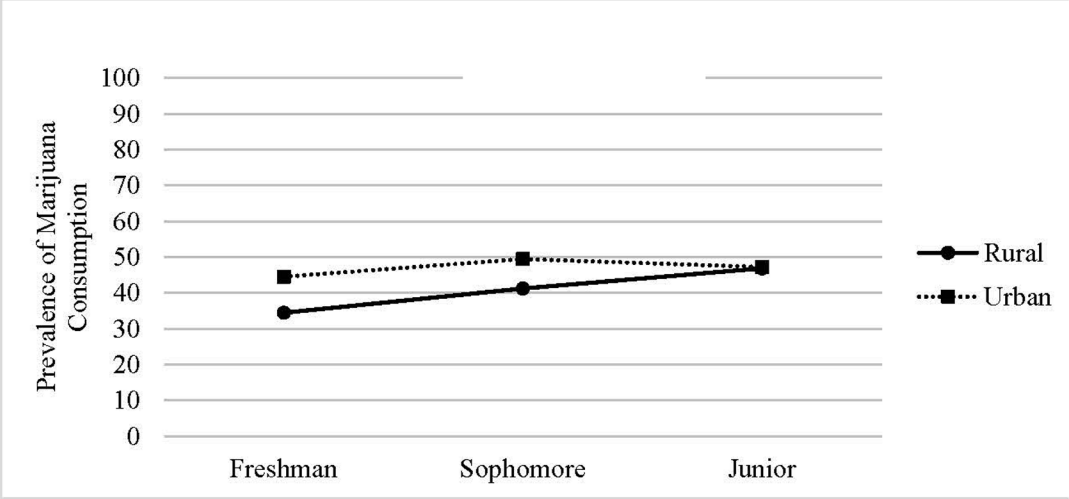

Figure 7. Prevalence of Marijuana Use among Rural and Urban Students.

Y-axis represents percent of group endorsing any use. X-axis represents year in college. Individual lines represent rural or urban student groups.

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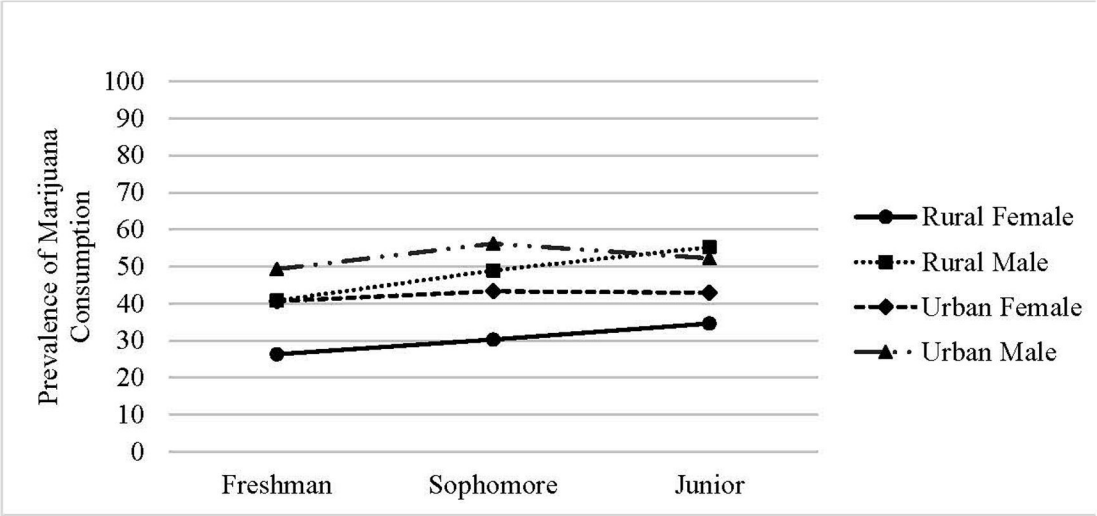

Figure 8. Prevalence of Marijuana Use among Male and Female Rural and Urban Students.
Y-axis represents percent of group endorsing any use. X-axis represents year in college. Individual lines represent rural female, rural male, urban female, or urban male student groups.

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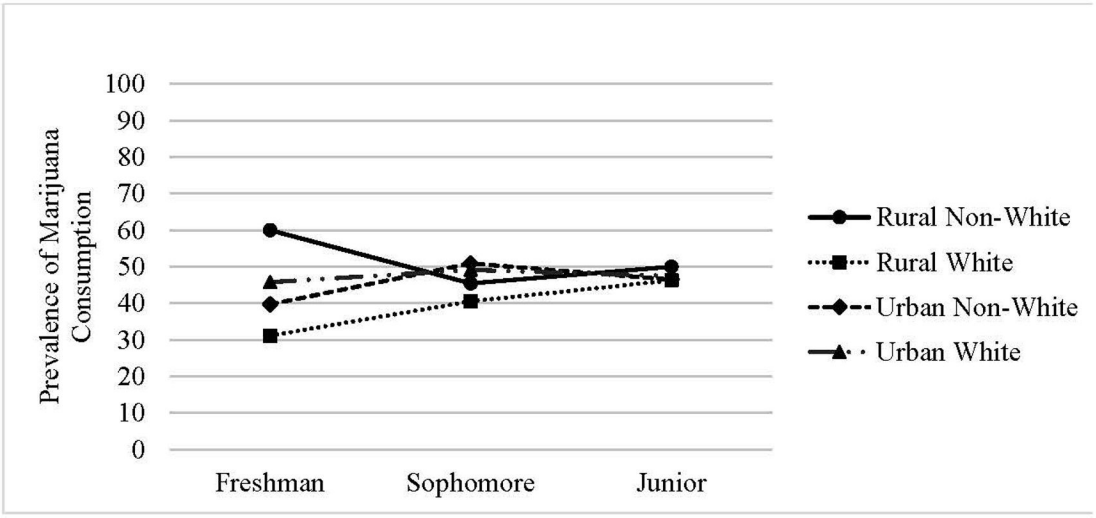

Figure 9. Prevalence of Marijuana Use among White and Non-White Rural and Urban Students.
Y-axis represents percent of group endorsing any use. X-axis represents year in college. Individual lines represent rural non-white, rural white, urban non-white, or urban white student groups.

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Table 1.

Sample characteristics, substance use prevalence, and comparison between urban and rural students.

	Overall (N=431)	Urban (n=337)	Rural (n=94)	Urban vs. Rural Difference p-value
Average Age Mean (SD)	19(0.8)	19(0.8)	19(0.8)	0.6164
>=21	1.7%	1.5%	2.2%	0.6458
Female	52%	55%	45%	0.0710
White	81%	80%	86%	0.1467
Alcohol (percent of students using by category)				
Freshman	87%	**89%**	**78%**	**0.0104**
Sophomore	89%	90%	83%	0.0544
Junior	90%	92%	89%	0.5217
Tobacco (percent of students using by category)				
Freshman	25%	25%	25%	0.9329
Sophomore	24%	23%	27%	0.5073
Junior	21%	19%	30%	0.0707
Marijuana (percent of students using by category)				
Freshman	42%	45%	34%	0.0912
Sophomore	47%	49%	41%	0.1926
Junior	47%	47%	47%	0.9540

Note. Demographic characteristics were assessed during freshman year. p-value represents significance of difference between urban and rural individuals on the given variable. Comparisons for the outcome proportions between rural/urban groups for each time point were performed with a chi-square test and Fisher's exact test in those cases where chi-square assumptions were not met. All comparisons were considered significant at the alpha level of 0.017.

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Table 2.

Perceived Peer Use by Year.

	Alcohol				Tobacco				Marijuana			
	Overall (N=431)	**Urban (n=337)**	**Rural (n=94)**	**p value**	**Overall (N=431)**	**Urban (n=337)**	**Rural (n=94)**	**p value**	**Overall (N=431)**	**Urban (n=337)**	**Rural (n=94)**	**p value**
Freshman	80%	**83%**	**72%**	**<.0001**	23%	**20%**	**31%**	**<.0001**	34%	**37%**	**28%**	**.0033**
Sophomore	84%	**87%**	**74%**	**<.0001**	25%	**23%**	**32%**	**.0099**	41%	**44%**	**32%**	**.0006**
Junior	88%	89%	84%	.0440	21%	**19%**	**35%**	**<.0001**	43%	46%	46%	.8660

Note. p-value represents significance of difference between urban and rural individuals on the given variable. Comparisons of the peer use variables for rural/urban groups for each time point were performed with a chi-square test. All comparisons were considered significant at the alpha level of 0.017.

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Table 3.

Multivariable GEE Regression Models for Repeated Binary Outcomes.

	Alcohol			Tobacco			Marijuana		
	OR	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**
Year									
Freshman (vs. Junior)	**0.57**	**0.39–0.83**	**0.0031**	1.23	0.97–1.56	0.0881	**0.79**	**0.63–0.99**	**0.0457**
Sophomore (vs. Junior)	0.69	0.48–1.03	0.0670	1.16	0.91–1.48	0.2237	1.01	0.84–1.21	0.9407
Rural/Urban Status	**2.21**	**1.23–3.95**	**0.0080**	0.86	0.54–1.38	0.5310	1.43	0.94–2.19	0.0964
Age	1.41	0.88–2.25	0.1511	0.89	0.67–1.21	0.4704	0.89	0.71–1.13	0.3572
Female	1.16	0.68–1.98	0.5925	**0.67**	**0.45–0.99**	**0.0466**	**0.67**	**0.48–0.95**	**0.0227**
White	**2.42**	**1.33–4.39**	**0.0040**	0.19	0.71–2.03	0.5055	0.92	0.61–1.41	0.7123

Note. Urban/rural x time interaction effects were not statistically significant. OR = Odds Ratio. A generalized estimating equations (GEE) marginal model (with exchangeable covariance structure) was applied for repeated binary measures in SAS PROC GLIMMIX to estimate rural/urban status, time, and their interaction effects while adjusting for demographics. This approach allowed us to make use of all available observations over time. All associations were considered significant at the alpha level of 0.05.

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